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ABSTRACT

This is a summary of the report entitled "Information Systems in the State of Minnesota 1970-1980" (available as LI 002 385). It is reproduced separately for the benefit of those not requiring the full document. It briefly discusses the three major sections of the report: State government, Higher education (available as LI 002 387) and Local government. The legislature, 12 agencies of the State government, and the three principal retirement agencies are included in State Government. The discussion of State Government covers current status and projected requirements, cost/benefit, and the State government systems plan (Minnesota Information and Decision Systems--MIDS). Minnesota's five systems of higher education were examined: (1) to determine specific objectives and uses of computers to meet them; (2) to summarize existing computing facilities; (3) to analyze computer facilities and services over the next five and ten years; (4) to determine costs; and (5) to recommend ways to meet needs and to lay a basis for future development. The status of mechanization at the local government level was determined by the use of questionnaires. The business of local government is particularly susceptible to assistance from computerization, but usually they have not been in a position to take advantage of this. Recommendations and guidelines for the efficient development of local government information systems and computerization are discussed. (SG)

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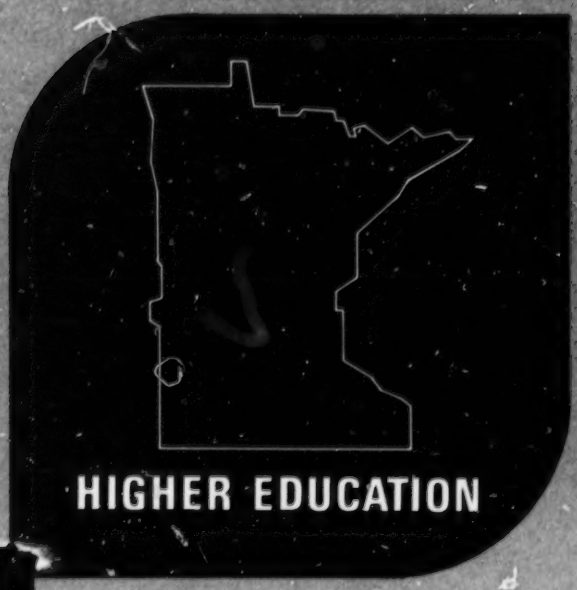
SUMMARY PART OF INFORMATION SYSTEMS IN THE STATE OF MINNESOTA 1970-1980



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PART II
SUMMARY

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INTRODUCTION

This part of the report summarizes Part I Introduction and the three substantive parts of the report: III – State Government, IV – Higher Education, V – Local Government. It is intended to serve those who cannot devote time to reading the entire report and to be available for distribution to those not requiring the full report.

The growth in the complexity and volume of requirements for service placed upon government at all levels and the resultant costs are among the phenomena of our time. The growing awareness of the interrelationships between and among the forces leading to requests for service, and a desire to look at the problems jointly rather than severally are, fortunately, further phenomena. In Minnesota, the State government, the higher education complex, and local governments are caught up in the growth, the complexity, the interrelationships, the costs, and all of the other problems related to the almost overwhelming rate and nature of change in society.

Although Minnesota enjoys a high "quality of life" rating among the states, in part attributable to its State and local governments, improved performance in all governmental operations is necessary to cope with the rapid pace of societal change and growing demands for service. Accentuating this are the significant population growth and the increasing affluence of Minnesota citizens. Heavy tax resources have, of course, been allocated to cope with these problems and their demands.

The tools of systems analysis and computerization hold out hope for improving governmental operations, governmental decision making, and the effective execution of those decisions. Realization of these hopes can come through direct and indirect cost/benefits affecting operational and management performance.

The concepts of information systems and decision systems have developed from the growing understanding of the application of systems analysis to the administrative functions of society. These concepts are based on the assumptions that rational decision making is based on information, that the quality of the decision is based in large measure on the quality of the information, and that much decision making is capable of being systematized.

Systems analysis by its nature must include all facets of an activity or function, not only its easily computerizable aspects. Of particular importance is analysis of the information requirements – of the data base that is necessary to provide that information. Computers have made possible the development and management of comprehensive data bases. Moreover, the economics of generally increasing costs on one hand and decreasing computer costs on the other hand are forcing the rapid development of information systems and computerization for direct and indirect cost/benefit. This trend is evident in the present expenditures for computer hardware in government; it can be expected that such expenditures will increase more rapidly than most other types of expenditures and that state and local expenditures for these purposes will increase at a faster rate than in the Federal government.

Each of the three segments covered in this report – state government, higher education, and local government – has considerable significance to the future of the State of Minnesota. It would be futile to suggest that one is qualitatively more important that the others. In a quantitative sense, the full-time equivalent employment data summarized below is one measure of the relative significance.

Although there is not necessarily a direct relationship between the number of employees and need for information systems and other computerization, there is indeed some relationship. On that basis, local government is where the greatest opportunity appears to lie, particularly in elementary and secondary education where both administration and instruction requires computerization.

Viewed on a broad basis, however, the real need is for comprehensive information systems to aid (a) the legislative bodies in setting priorities and funding programs and (b) the administrative officials in executing those programs. The four year growth rates in all areas are evidence of the growing urgency to make optimum use of these new technologies in administration and management.

It should be noted that discussions and recommendations concerning the area vocational technical schools (AVTS) are found in both the higher education and local government parts of the report, reflecting the AVTS's relationships with both the Minnesota Higher Education Coordinating Commission and the State Board of Education.

MINNESOTA STATE AND LOCAL PUBLIC EMPLOYEES 1969 FULL-TIME EQUIVALENT BASIS

Year	Education			Non-Education			Total		
	State	Local	State and Local	State	Local	State and Local	State	Local	State and Local
1969	17,304	65,407	82,711	24,713	45,513	70,226	42,017	110,920	152,937
4-Year Growth	47.5%	17.1%	22.3%	12.1%	8.9%	10.0%	24.4%	13.6%	16.4%

Source: Public Employment in the United States 1965-1969
U.S. Department of Commerce
Bureau of Census

STATE GOVERNMENT

In 1957, the Minnesota Legislature laid the basis for a gradual centralization of the State's data processing facilities by setting up a Central Services Division in the State Department of Administration. In 1960, most of the State's tabulating installations were merged into that division. A principal result of that beginning and the subsequent developments is that Minnesota has avoided much of the extensive and expensive proliferation of computer equipment, personnel, and space that inevitably accompanies separate computer operations.

Like other states, however, the importance of the systems analysis function has not been clearly recognized until recently. Although computer applications were designed, insufficient attention was given to management information; and systems analysis was generally limited to the easily "computerizable" characteristics of a function.

In 1966, the State Planning Agency drew attention to the growing need for information systems for each segment of the State administration. In 1967, the Governor and the Legislature agreed to a $500,000 special appropriation for computer acceleration and set up a Computer Services Division (CSD) in the Department of Administration. The Governor also established the Governor's Committee on State Information Systems, a committee which has played a major role in subsequent developments including calling for this report.

The Governor, by Executive Order in 1968, gave the Computer Services Division broad authority and responsibility in the State's computer efforts. Significant action took place on many fronts in the next two years including another special appropriation by the 1969 Legislature, this time in the amount of $900,000 with $300,000 earmarked for higher education. In 1970, the Governor issued another Executive Order on the subject of information systems, further clarifying the State's direction. Shortly thereafter the Commissioner of Administration reorganized the Computer Services Division, equipping the division to provide better service to its users and to set up a Local Government Unit to assist in local government coordinating efforts. Shortly thereafter, the computer functions of the Department of Highways were merged into the Computer Services Division, leaving only the Department of Manpower Services with a separate computer installation.

Since 1967, significant progress has been made in building the Computer Services Division. The division was strengthened in structure, personnel, and equipment and converted to a heavily multi-programmed operation under full operating systems. Further, extensive progress has been realized in coordinating systems and computer development in State government and higher education.

This part of the study included the Legislature, twelve agencies of the State government, and the three principal retirement agencies. The combination of agencies accounts for over ninety percent of the budget, employees, and computer expenditures of the State, exclusive of higher education. Much of the study effort was devoted to interviews with management personnel of the agencies to determine information needs, both present and prospectively. The results of the interviews were summarized for each department. Inventories of personnel, equipment, and applications were also obtained and analyzed. Departmental informational interrelationships were identified.

CURRENT STATUS AND PROJECTED REQUIREMENTS

From its first IBM 650 computer in 1959, the State computer capacity now consists of two IBM 360-50's, an IBM 360-40, an IBM 360-25, an IBM 1401 (at Manpower Services to be replaced soon by an IBM 360-40), and a UNIVAC 418-II. The first three of these are multi-programmed under full operating systems. One IBM 360-50 and the UNIVAC 418-II operate in communication mode, the 418-II serving as the basis for MINCIS (Minnesota Crime Information System) and interfacing with the 360-40 on which both the driver license and motor vehicle files are maintained.

Four of CSD's largest applications are heavily involved in on-line input, updating, and/or data retrieval: MINCIS, driver's license, motor vehicles, and income tax. The Division's planning assumes that in time most of the State applications will be available for on-line update and retrieval. A wide variety of applications is handled by the Division which services most agencies of the State government.

Effective management of the systems and computer function, of considerable interest to Legislators and top administrators alike, is a complex task. Principal factors are the quality of systems analysis, personnel performance, and efficiency of equipment and its use.

A comprehensive systems approach is necessary in designing cost effective information systems. Too often in the past such an approach has been missing, not only in state government but nearly everywhere. An entire system must be reviewed, not just a portion that someone wants to "put on the computer." This is an extremely difficult task because the management of any significant activity is complex and the systems necessary to assist with that management are also complex. The task obviously cannot be done effectively unless each manager assures himself that the system is in detail what he needs – as an example, not just to account for tax collections, but to give the manager and his principal subordinates what they need for the research, planning, and control aspects of tax administration.

The ratio of hardware cost to total computerization costs in administrative data processing approximated 2 to 1 a few years ago. Now it is typically about 1 to 2. Thus, the management of computer personnel, always a major task, has taken on added relative importance. Controlling the personnel turnover of computer professionals with proven competence and comprehensive knowledge of large and complex systems became critical.

Particular interest has been expressed in the efficiency of computer equipment and its operation. It requires an evaluation of many factors including computer speed and memory size, multi-programming, utilization, scheduling, peripheral equipment, and productive use. Utilization is a particularly difficult evaluation since there is no one definition of utilization which fits all situations. Minnesota State government computers have been generally utilized heavily by any standard in recent years – so heavily that customer service has been occasionally impaired. Recent additions to the State's computer hardware have provided a slight but temporary cushion for additional applications. Completion of all aspects of the recent reorganization of the State computer facilities is necessary to maximize efficiency of operation.

Information Systems Costs

The approximate costs of the State systems and computer operations have increased from $2,000,000 in 1966 to $5,100,000 in 1970. The last three years have shown an increase of about 32 percent a year. The figures are incomplete because costs have not been accumulated statewide, a deficiency to be corrected by a new State accounting system now under development.

A number of factors are expected to lead to constantly increasing computerization spending over the coming years. These include economies

of computerization versus manual methods; increases in the volume of State business; additional State services; data requirements of Federal agencies; increasing sophistication in systems design and comprehensiveness of computer services; more productivity from systems and programming personnel; and increase in the State's service to local governments. On the other hand, the growth in comprehensive information systems will put a downward pressure on other costs, both through direct and indirect cost/benefits. To obtain data on which to project future budgets, several factors were reviewed.

- A large number of applications were identified in the course of the study. It was estimated that 497 applications would be in operation by 1975, compared with 332 at present. To reflect increasing complexity and comprehensiveness of new applications, a weighting factor of 2 was assigned to the 265 expected new applications to permit comparison with the present 332. The net results was that the 1975 application load on a basis equivalent to 1970 would be 762.

- The trend in the State's expenditures shown previously amounted over the past three years to an average annual increase of 32 percent.

- A comparison was made of the growth trend in the overall State expenditures and the expenditures for State computer operations. The latter as a percent of the former shows a significant increase over the past five years, a trend almost certain to continue.

- Computer hardware costs among several states (Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin) show that Minnesota is (a) in a middle group on cost per resident although low until 1968 and (b) lowest in cost per state employee in 1967 and 1968 but in 1969 higher than Ohio and equal to Michigan. Such figures are merely indicative since qualitative and performance considerations are omitted. (In fiscal 1970, Minnesota State government information systems costs approximated $1.35 per resident and $207.00 per State employee.)

Although no specific budget recommendations are made, it is suggested that a curve reflecting the estimated increases in applications would be the most likely base for realistic budget planning which, if used, would result in an annual increase over the next five years of about 24 percent. Thus, the 1975 fiscal year would show a total of $14,900,000 compared with the 1970 total of $5,100,000. Budget projection beyond that period was thought to be totally infeasible.

COST/BENEFIT

As a generality, information systems and other computerization efforts will not survive unless cost effective. The measurement of the benefit, however, has often not been made at all or in some cases made incompletely. Among the reasons for this are: costs of existing systems are not known; follow-up on new systems to assure cost/benefit realization often is ignored; new systems bring benefits not previously available; impact of higher workload may be overlooked; inflation's effects may be ignored. Because of the general lack of detailed feasibility studies prior to computerization and the deficiencies in the State accounting system it has not been possible to present an authoritative statement of cost/benefits in Minnesota.

In one example, some facets of income tax processing, it is conservatively estimated that direct personnel cost avoidance since 1964 amounted to the annual amount in 1969 of $230,000. There is substantial evidence that the unit costs of income tax return processing, excluding effects of salary schedule increases, decreased by about 13 percent in that period and this in spite of more extensive and complex processing requirements. A well-documented study of certain Department of Highways engineering tasks showed that pre-automation costs of $2,748,875 were reduced by computerization to $1,129,971, a reduction of $1,618,904 or nearly 59 percent of the original cost. The indirect cost/benefits, such as are to be

found in MINCIS and many other systems, will probably far exceed direct cost/benefits.

Minnesota's decision to centralize its computer central processors produces direct cost/benefit. A hypothetical analysis generated a theoretical potential savings of about one-third. Even a half of this potential would provide a large saving when measured against the probable $15,000,000 budget in 1975. But effective administration is necessary to obtain the advantages of such centralization while avoiding its potential disadvantages.

THE STATE GOVERNMENT SYSTEMS PLAN

A plan outlined here for Minnesota State government and designated as MIDS (Minnesota Information and Decision Systems) aims to achieve two primary objectives:

- To make available to the Legislature and to officials of the Executive Branch comprehensive and accurate information in a form and at a time to be of maximum value in decision making and research.
- Provide to all State personnel the most effective framework of systems, procedures, and methods within which to carry out the operations of the State.

The implications of implementing MIDS are enormous. In its broadest terms, MIDS means defining, designing, and installing comprehensive systems for each area of government to serve as the framework for attaining optimum effectiveness of State operations. A major requirement is the ability to associate and interrelate the data bases of the information systems serving major functional areas of government. Corollary to this is the installation of procedures to assure the integrity and confidentiality of data.

Action necessary to implement MIDS is recommended under five headings:

- Comprehensive systems approach
- Organization structure
- Guidelines for development
- Security and confidentiality of data
- Intergovernmental coordination.

A more comprehensive systems approach to the problem of the State. The recommendations are:

- Assignment of overall responsibility for design, coordination, and implementation of MIDS to one agency of the government. Executive Order No. 56 should be interpreted to include *all* systems analysis (not just the computerizable aspects) and incorporated in the State statutes.
- More effective execution by the top executive in each agency of State government of his responsibility for clarifying the objectives of each function of his agency and for specifically approving the general systems required to reach those objectives.
- Attendance by top management personnel of all agencies of State government at intensive courses in systems analysis, information and decision systems concepts, and computer familiarization. Legislators and legislative staff members should be invited to participate.

An organization structure effective in coordinating the design of the many major systems, building efficient operational systems for all areas of State government, attaining maximum productivity from the State's systems and computerization efforts, and providing assistance to Local government. The recommendations are:

- **The State information systems function should be strengthened by improved organization and by statutory centralization in that organization of authority over development and operation of information systems and computerization.** The growing importance of information systems to the operation and management of the State government calls for improving the organization of that function either by further strengthening the structure within the Department of Administration or by establishing a new

Department of Information Systems. For the organizational alternative selected, the most important requirement is that appropriate responsibilities and authority be given to the function. The acronym DIS of this report refers to a Division of Information Systems, and its administrative officer is referred to as Director of Information Systems.

- **All systems and computer functions of the State administration should be administered or controlled by DIS.** This recommendation is consistent with the basic organizational concepts being implemented in Minnesota. Internal organization of the division should be built on the Computer Services Division and should consist of these six sections:

1. Systems and Programming with present responsibilities broadened to include *all* systems analysis and design, not just computerizable segments of systems.

2. Planning and Coordination with responsibilities for research, standards, staff development, and higher education coordination as presently but adding two units. One is a Methods Unit to carry out certain systems functions such as forms control, records management, and work measurement and to provide certain systems specialization such as in microfilming. The second is a Management Science Unit to maintain a comprehensive index of all State files, advising and assisting State personnel in how best to obtain and analyze data from those files, and introducing the use of operations research techniques in the analysis of State problems.

4. Telecommunications Section administering all communications functions of the State.

5. Local Government Section with primary responsibility to serve as staff to the Intergovernmental Commission on Information Systems recommended in the local government part of this report.

6. Administrative Services Section carrying out the tasks generally assigned to such divisions in the State. Of particular importance in DIS is the controllership function because of the need for sound data in feasibility analysis and in the cost accounting necessary to the Division's operation.

- **Expenditure Control.** Legislation should be passed to continue in DIS the authority in Executive Order No. 56 to review and approve all proposed expenditures by any agency of the State government for systems development or computerization (equipment, personnel, programs, space, systems design, consultants, service bureaus, etc.) and extension of the authority to cover all systems activity.

- **Governor's Committee.** Legislative action is recommended to formalize the present Governor's Committee on State Information Systems or a similar group to advise the Governor, the Legislature, and DIS on MIDS plans and progress and to recommend on the expenditure of developmental funds.

- **Agency Systems Coordination.** The development and implementation of management systems is a complex matter requiring the attention, coordination, and authority of top management of the user agency. Accordingly, a systems coordinator should be appointed by each major agency of State government, reporting directly to the agency head or to his chief deputy or assistant.

- **Communications Advisory Committee.** Proliferation of communications systems, leading to duplication and overlapping, will result unless coordination is effected. As a vehicle for assuring the needed coordination, it is recommended that a Communications Advisory Committee be

established, chaired by the DIS Telecommunications Section head. Membership should include representation from higher education and local government; major State users such as the Department of Highways; and State computer, radio, and telephone technicians.

Planned, controlled development of systems, procedures, and methods – computer-based or otherwise – to optimize the value of data bases and information obtainable therefrom for decision making and research, and to provide the most efficient tools for State employees to carry out the activities of State government.

- **First and foremost is the need for DIS and its user agencies to work together efficiently.** It is axiomatic in this field that only truly cooperative efforts are successful. Specific action that should be taken includes:

  1. Establishment of a MIDS User's Committee to serve as a primary communication device in the implementation of MIDS. The committee should consist of the Systems Coordinator from each of the major agencies of government, the DIS Director, and the appropriate section heads of DIS.

  2. Agency Systems and Computer Planning accomplished jointly by the agency Systems Coordinator and the DIS Major Systems Manager for that agency. It is strongly emphasized that the Systems Coordinator, as agency representative, must assume the key role in planning so the plan will reflect the agency's real needs, not the DIS view of those needs.

  3. Formalized and continuing training programs for agency personnel at the operating level. A spectrum of subjects should be covered including systems; controls; systems conversion techniques; input alternatives; computer techniques for data storage, management, and retrieval; general computer capability; etc.

  4. Formalized methods of communication between DIS and its users. These should include procedures for requisitioning service, for advising on progress, and for reporting on problems.

  5. DIS Newsletter. A simple newsletter, prepared monthly, could be helpful in the continuing orientation of agency personnel to the accomplishments of DIS users and to DIS capabilities.

- **The following guidelines should be adopted for MIDS:**

  1. A systems philosophy aimed at assisting the decision making process as contrasted with simply mechanizing or otherwise improving a production system.

  2. A systems design to permit integrated systems. This requires the development of standard identification systems for persons, organizations, physical assets, etc.; standard data definitions; and standard computer techniques for file management.

  3. Cost/benefit analysis to establish system feasibility.

  4. Computerization developed in an environment based on centralized central processing units and whatever remote terminals are necessary to serve users.

  5. Operational objectives of on-line files for real-time retrieval of information and on-line entry and update of data originating where feasible in the user agency.

  6. Attaining maximum output from both equipment and personnel.

- **The centralization of administration and control of systems development and computerization should be completed.** Specific action necessary to complete the centralization includes:

  1. Transfer of the computer functions of the Department of Manpower Services to DIS. Appropriate systems personnel should remain assigned to MSD, as

with other major departments, to assure systems design responsive to the needs of that department.

2. Developing a schedule for phasing out tabulating machine installations in favor of computerization, including provision for remote terminals where appropriate.

- **Systems activities must be economically justified.** Each systems design which is recommended for implementation – whether to be on a computer or otherwise – must be analyzed, and the feasibility of implementation determined. If feasible, and if implemented, then a planned follow-up must be completed to assure that the "pay-off" was realized or to discover why not.

- **Adequate physical facilities must be provided DIS.** At present the space allocated falls short of minimum requirements. The two computer installations are on opposite sides of the Capitol Mall, preventing optimum use of the computer equipment. Both computer rooms are jammed so full of equipment as to impair the efficiency of computer operating personnel. Neither room is built so that acceptable security standards can be assured. Space assigned to the Centennial Building keypunch section is extremely crowded and generally not conducive to maximum productivity. Space for computer professional personnel is at the crisis point.

- **Personnel costs are constantly growing as a percent of the overall costs of systems development and computerization, with the result that increasing emphasis must be placed on proper management of the staff.** Guidelines in personnel management should include: (a) establishment and enforcement of systems design and programming standards; (b) scheduling and controlling all systems and programming projects; (c) conducting formalized periodic performance reviews; (d) installing training and development programs; (e) assuring competitive posture in classification and salary structure; (f) use of existing systems when practicable; (g) selectively engaging consultants as specialists or to provide overload assistance; (h) assuring comprehensive documentation to maintain continuity. These guidelines in the main have been followed by CSD. The quality of results will be in direct proportion to the supervisory attention given to their enforcement.

- **Computer capabilities of the State will require expansion as the applications increase.** Centralization provides the framework within which that expansion can be done most efficiently. Recommendations related to equipment requirements are: (a) the "Model State Contract" for leasing or purchasing computer hardware should continue to be used by the State; (b) the requirements for compatibility must be given appropriate weight in obtaining additional or replacement equipment; (c) communications networks should be centered on one computer with strong communications handling capabilities; (d) appropriate back-up equipment should be available; (e) to attain the substantial savings available through purchasing rather than leasing, computers and related equipment should be purchased outright or under lease purchase plans when there is reasonable expectation that equipment obsolescence will not occur prior to the breakeven point; (f) peripheral equipment from other than the vendor of the central processing unit should be obtained where cost effective; (g) computer utilization records should be kept on all equipment and should reflect each of the methods of measuring utilization; (h) special emphasis should be placed on evaluation of methods and equipment for input preparation because of its large potential for cost reduction.

- **A number of further actions are necessary in the implementation of MIDS.**

1. Data Dictionary and Standardization of Data Elements. In the recent reorganization, CSD set up the new position of Manager-Standards and Quality with the major objective of

establishing a data dictionary and, corollary thereto, standardizing the structure of data elements and identifiers. Because there is probably no single function more important to the long-range objectives of MIDS, this program must be given top priority and top level support.

2. Controls. No principle in computerization is so basic as the need for controls. GIGO (garbage in – garbage out) has scuttled more computer installations and damaged more user relations than all other problems. It is essential that adequate controls be established; continued failure or unwillingness by any user agency to provide control information or by DIS to establish and administer accuracy controls is a matter for prompt discussion at the Commissioner level.

3. Standards for Systems Analysis and Programming. Standards should be established for all elements of work performed by systems and programming personnel – for example, documentation of existing systems, feasibility analyses, programming conventions, and program documentation.

4. Unified Operational Environment. Many of the remaining second generation programs should be reprogrammed to the third generation computers. In addition, a single set of programming conventions, similarity of operating systems, and standardization of teleprocessing and graphics network and interface control programs must be accomplished.

5. Customer Billing. Development of a new billing system should be given high priority as a major aid to the DIS internal management information system and as an aid in user relations. The new system must, of course, be consistent with both the new State accounting system and the State program budget requirements.

- **Adequate financing is essential.** It is recommended that future funding for all new systems development follow the precedent set in the 1969 special appropriation. That is, all funds for proposed new applications or resystematizing of major existing applications should be included in a special appropriation to DIS. Assuming the continuance of the Governor's Committee on State Information Systems, that committee should advise the DIS Director on the expenditure of those funds. It is also recommended that an amount in addition to that necessary to fund the known new applications be included in the special appropriation for applications where the time table should be accelerated.

  A possible level of funding for MIDS is identified in Section 2 of this part. Additional funding recommended is $3,000,000 for adequate space for DIS, $1,900,000 to assist local government with development efforts – see Part V of this report, and an addition of $250,000 to the computer revolving fund for purchase, rather than lease, of certain equipment.

- **Performance evaluation is desirable for all functions, but it is mandatory for DIS because of the growing impact it has on State government functions and decisions.** An evaluation is already being performed to a limited extent by the State Public Examiner's Office and should continue to be the responsibility of that office.

The development, installation, and policing of subsystems for assuring the integrity of computer-based and all other data and to assure confidentiality of such data by limiting its accessibility only to properly authorized persons.

In this recommendation, attention is focused on the need for assuring integrity of data files by preventing willful tampering with data and by providing detailed procedures for the correction of erroneous data or elimination of obsolete data. Further, and most important, is action necessary to safeguard private rights by establishing

procedures to guarantee confidentiality of data. It is emphasized that all data are included, not just computer-based data.

Accordingly, it is recommended that the Legislature enact legislation establishing State and local government policy on integrity and confidentiality of all data and direct the Director of Information Systems and the Intergovernmental Commission on Information Systems (see Part V of this report) to give priority to implementing the policies.

A leadership position in the development and coordination of intergovernmental information systems and of intergovernmental cooperative efforts in systems analysis and computerization. In every way possible, DIS should encourage and participate in intergovernmental efforts. For example:

- Encourage Federal agencies to fund the development and implementation of major information systems for State and local governments.

- Corollary to the above, encourage direct Federal and State participation along with local government in the development and implementation of local government information systems.

- To the extent feasible, promote Minnesota State or Local government agencies serving as prototypes in systems development as suggested above.

- Encourage joint local government development of information systems, assisting where possible with State personnel and funding.

- Promote the utilization of existing, successful applications including individual programs as well as broader groupings of applications.

- Support with personnel and funding any programs of NASIS (The National Association for State Information Systems) to promote common systems, intergovernmental data interchanges, data and operating standards, and any other NASIS efforts furthering State and Local information systems.

- Coordinate and assist with the development of data bases of statewide or regional value, such as MAPS at the University of Minnesota and RAFT developed by the Citizen's League and the Upper Midwest Research and Development Council.

HIGHER EDUCATION

In the State of Minnesota there are five "systems" of higher education, each comprised of numerous separate institutions or campuses distributed throughout the state: the University of Minnesota the State College System, the State Junior College System, the Area Vocational-Technical Schools, and the Private Colleges. Each of these five systems has as its mission one or more of the three traditional objectives of higher education in the United States: *Instruction,* including vocational, professional, and general education; *Research,* defined as the expansion of knowledge and the development of techniques, methods, and devices for solving problems related to the natural world and to man and his social institutions; and *Public Services* to government and society. The entire thrust of this study has been to determine the computing facility and service needs of Minnesota post-secondary institutions in terms of their particular and diverse objectives, and to find and suggest ways of satisfying these needs which have the greatest likelihood of being implemented. To this end, educators and administrators from numerous institutions in all five systems throughout the state, as well as from other states, were consulted extensively before and during preparation of the report.

The objectives of each of the five major sections of this part of the report are as follows:

- To identify the specific objectives of each of the five systems and the importance of computers in meeting these objectives, both directly as a part of the process of instruction, research, and public service, and indirectly through support of learning resources, student services, and general administrative operation of institutions (Section 1);
- To summarize the existing (1970-71) computing facilities and applications in Minnesota higher education, and their costs (Section 2);
- To analyze the needs of Minnesota higher education for computing facilities and services over the next five and ten years (Section 3);
- To determine the costs of various ways of meeting these needs, identifying the least expensive ways (Section 4); and
- To recommend specific actions by the institutions and systems of higher education and the legislature to meet the identified needs and lay a sound basis for future development (Section 5).

COMPUTERS AND THE OBJECTIVES OF HIGHER EDUCATION

Without going into the detail and citing some of the examples to be found in the complete report, there are few areas of higher education in which computers or information processing systems have not already been applied in some way. Computers are both an object of instruction (for students in computer science, data processing, and other engineering fields) and a tool of instruction in fields as diverse as the basic sciences, social sciences and art and music. One of the few ways in sight to control the rapidly rising costs of higher education, and at the same time perhaps improve its quality, *may* be the as-yet-unproven direct application of information systems to the process of instruction — Computer-Assisted Instruction and Computer-Managed Instruction. In research, computers are similarly an object of study and development in the areas of engineering and

information sciences, and an indispensible tool in most research fields of science, engineering, social science, medicine, and many of the humanities. Use of computers in both the instructional and research missions of higher education has overlapped considerably into the public service area already — in-service training for personnel from schools, public agencies, and industry, as well as development of applications to problems of planning and operations in public and private organizations. The potentials for further public service applications of this kind can be substantially increased through suitable communication and coordination between higher education and other segments of society. Finally, higher education is one of the largest "industries" in the State of Minnesota. Its administrative processes are similar to those of any other "industry" group. The economic savings resulting from a coordinated use of computer and information systems in higher education are considerable, just as they are in commerce and industry.

In 1967, a Committee led by John R. Pierce of the Bell Telephone Laboratories issued a report *Computers In Higher Education,*[1] under the auspices of the President's Science Advisory Committee. In addition to presenting a most compelling justification for the substantial use of computer systems in higher education, the *Pierce Report* established a norm for the amount of computer capacity needed — namely, that all institutions of higher education should be at least as well equipped in facilities and programs as were the best-equipped colleges and universities in 1967. Because of the wide disparity between the best and the average in 1967, and because of the generally slow pace of funding since then, these goals are still reasonable ones for Minnesota higher education in the coming decade. The *Pierce Report*[1] is referred to extensively in this study of Minnesota's needs.

EXISTING COMPUTING FACILITIES AND PROGRAMS

The University of Minnesota is the State's largest system of higher education as well as its primary resource for graduate and professional training, research, and public service. It is also the leading state institution in computer facilities and related research and training programs. The University is equipped with a major administrative data processing system which is used to capacity, plus a large system for instruction and research which includes a major computer (the CDC 6600) and several small satellite computers or input/output stations. With the exception of a medium-sized computer serving the Duluth campus, other computing facilities at the University are special-purpose devices built into laboratory apparatus or otherwise dedicated to special applications, and funded almost exclusively by federal or private grants.

With its recent acquisition of a Univac 1106 computer, Mankato State College is surely one of the best-equipped non-PhD-granting colleges in the nation. However, this computer is intended to serve the needs of the other state colleges and outside users as well. Until the magnitude of outside use is established, the adequacy of the 1106 will be undetermined. The remaining five state colleges each have small, obsolete computers with capacities considerably below their present needs for instruction and administrative processing.

The State Junior College System has a small, second-generation computer which provides adequate administrative service for the eighteen junior colleges at present, but with little possibility of expanding the kinds or amount of service. Beginning this year, each of the eighteen colleges is also connected to a commercial time-shared computer service in Minneapolis for instructional computing — the first access they have had for this purpose. These tie-ins were made possible by a $60,000 grant from a special appropriation by the 1969 Legislature to the Higher Education Coordinating Commission.

Data processing curricula are alive and prospering in the three Area Vocational-Technical Schools which have small computers for this purpose. They exist in less prosperous condition at several other schools which make use of small school

board computers, or facilities made available on undependable terms by nearby business concerns.

Finally, computing in the private colleges ranges from generously adequate by present standards to zero. Partly by necessity, the private colleges seem to be more involved in cooperative activities among themselves and with public institutions; the Twin Cities College Computer Committee involving seven Twin Cities area colleges and the University of Minnesota is the largest such group.

The table below summarizes order-of-magnitude equivalent purchase costs of existing computer facilities in Minnesota higher education, extracted from Tables 2.1 and 5.1, and from Appendix H.5 of the complete report. The numbers have been rounded to the nearest $100,000 and represent equivalent purchase cost.

University of Minnesota	$ 6,400,000
State College System	2,200,000
State Junior College System	200,000
Area Vocational-Technical Schools	800,000
Private Four-Year Colleges (Est.)	850,000
TOTAL	$10,450,000

Computer industry marketing data is available on a confidential basis to compare Minnesota with other states. Although this information is not an accurate source of total expenditures for equipment, it does provide a reasonably uniform basis for comparison. Among the seven Big-10 midwestern states, Minnesota ranks fifth in public spending for computer facilities in higher education, and fourth in spending among private colleges (Figures 2.1 and 2.2). Compared with the standards established by the Pierce Report[1] which recommended a $414 million national expenditure for computing in higher education, Minnesota ought to be spending about 2% of this amount, or $8 million. Actual equivalent annual lease plus staff, maintenance and operating support is estimated at about $4.2 million for 1970-71 (Table 5.1 plus a generous contribution of $500,000 for all of the private colleges).

GOALS AND COMPUTER RESOURCES NEEDED TO MEET THEM

The goals toward which the analysis of this and the next section are directed are two:

- Achievement of the *Pierce Report*[1] objectives for educational computing in the State of Minnesota, i.e., to provide educational computing services for all of higher education in Minnesota equivalent to that available at the leading universities of the nation in 1967-68.
- Establishment of machine-readable data bases and an administrative data processing capacity which is sufficient to support the management information needs of institutions and systems of higher education and lay the basis for program planning and budgeting.

In this section the computer capacity necessary to meet these goals will be estimated, in terms of the required number of input/output terminals of various kinds, computing power required in statements compiled per second, and the amount of mass data storage needed. The following section will convert these capacity estimates into cost estimates.

The capacity estimates for educational computing are based on the *Pierce Report* breakdown of academic areas into those requiring substantial use of computers, limited use, and casual (very little) use. Following a procedure used in a feasibility study by the General Learning Corporation[2], it was estimated that, averaged over all kinds of students in Minnesota colleges and universities, the computers would need to handle 11.3 problems per year for each full-time equivalent student. Each problem would contain about 70 compute statements to compile. If carried out on a time-shared computer system, between 1.1 and 1.8 hours of terminal time would be required for each problem, depending on the skill of the student. On a batch processing system using medium-speed remote terminals, between three and six runs would be required to complete each problem, depending on the

complexity of programming language used. Although such numbers may not be typical of any particular computer used by students, they have been accepted as reasonable estimates of overall use by most of the educators and computer specialists consulted during the course of the study. Further details of the analysis, along with modifications included for junior colleges and area vocational-technical schools, may be found in the complete report and in Appendix H.6. Results are summarized in Table 3.1.

It proved to be more difficult to estimate the computer capacity required to support the administrative data processing needs of Minnesota higher education, because no quantitative national norms or feasibility studies were found to guide the analysis. Therefore, the University of Minnesota, which has the most complete administrative system in the state, was used as a model. Most of the possible administrative applications are in either the operational or planning stages at the University, and the isolated exceptions (a computer-based student registration system, is the major omission) were added on the basis of a crude but reasonable design study. The administrative computing resources required by the other collegiate institutions were estimated then by scaling according to enrollment, staff size or other appropriate application-dependent quantities. (Area vocational-technical schools were omitted from this analysis, since their administrative processing is handled by the school districts to which they are attached — units of local government.) Details of this analysis are explained in Appendix H.6 and tabulated in Table H.6.8, while the results appear in Table 3.2.

The small table below provides a brief summary of the estimated computer capacities required in 1975-76 for all of the Minnesota collegiate institutions — University, State Colleges, State Junior Colleges, and Private Colleges.

Research and public service computing needs have not been included in this analysis. It should be kept in mind, however, that access to sufficient computer capacity is needed by those institutions with missions in these areas, but that the cost of providing such services is normally covered by the outside sources which fund or request them. There were three special computer applications in higher education which merit specific discussion:

TOTAL ENROLLMENT	174,163
EDUCATIONAL COMPUTING	
Batch Processing	
No. Medium-Speed Terminals	90
No. Statements Compiled Per Second	215
Time-Shared Computing	
No. Terminals	1,214
No. Statements Compiled Per Second	1,214
ADMINISTRATIVE DATA PROCESSING	
Mass Storage (millions of characters)	1,992
Required Peak Output Rate (lines per minute)	2,707
Required Peak Computer Processing Rate (transactions per minute)	6,349

- **A Statewide Automated Library System,** which has the potential of substantially increasing the quality of library services available throughout the state, and at the same time controlling an otherwise inevitable cost escalation and service deterioration associated with the explosion in volume of printed information.
- **Computer-Assisted and Computer-Managed Instruction,** which hold promises of substantial increases in the effectiveness and efficiency (cost savings) of higher education if the techniques and technology are carefully and properly developed and applied.
- **Information Services,** building partly upon several research projects at the University and providing ready access and analysis of planning information required by many public agencies and private organizations throughout the State.

The first two special areas listed are sufficiently important to higher education that experts were consulted during the course of this study, and asked to prepare position papers which appear as Appendices H.2 and H.3. The third area is of sufficient interest to other public agencies that it is discussed in the State and Local Government parts of this report.

FACILITIES AND COSTS TO MEET THE GOALS

Having estimated the amount of raw computer power, input/output capacity, and mass data storage needed by Minnesota higher education, the next task is to convert these estimates into reasonable configurations of computer equipment to which costs can be assigned. The largest components of the total cost are the computers themselves. Using benchmark test data from the Auerbach Reports, plus the personal experience of several staff members of Analysts International Corporation, a scale was constructed relating computer cost to computing capacity, as measured by the number of FORTRAN- language statements compiled per minute or data processing transactions executed per minute. (The scale is given in Figure 4.1 and in Table H.7.1 of Appendix 7.) Then this scale was used to convert the previous computer need estimates for Minnesota higher education into cost estimates for three kinds of computer systems:

- Systems supporting only batch processing via local and remote terminals (except for the junior colleges, for which a small, central time-shared computer is less expensive).
- Systems supporting time-shared and batch computing on the same general-purpose computers.
- Separate computer systems to provide batch processing and time-shared computing, using for the latter small computer configurations especially designed to process the short student programs and interactive applications characteristic of much instructional computing.

One observation resulting from this analysis is that instructional time-shared computing can be carried out most economically on a small computer system dedicated to this use. The cost is not much greater than that of the equivalent instructional computing carried out on a large batch-processing computer.

In a similar fashion, a scale was constructed relating the mass data storage capacity of various magnetic disk and drum units to their cost.

A more difficult task was the configuration of remote terminal systems to connect various institutions to central or regional computer systems. The components required for such systems include the computer terminals themselves (input/output devices); modems or data sets to interface these to communication lines; communications controllers to efficiently match the computer to communication lines; multiplexors to concentrate data from or to several terminals over one communication line; and a variety of communication line services available for data transmission. Costs were

estimated for a spectrum of each of these components, and then the costs associated with several different geographical deployments of computer and terminal equipment were analyzed for each of the five systems of higher education. Included with equipment costs in these analyses were operating support costs -- staff, salaries, supplies and auxiliary equipment, and maintenance — without which no computer system can function. Adequate operating support was estimated from published data and past experience to equal the equivalent lease cost of equipment for educational computing, and to be twice the equivalent lease cost for administrative data processing.

Complete details of this analysis may be found in Section 4 of the report, supplemented by Appendices H.7, H.8, and H.9. Those readers who are not familiar with remote terminal computer configurations and the functions of the many components they contain may find it helpful to refer to Figure 4.2 and its accompanying text. In Table 4.5 are summarized the resulting monthly costs of the various configurations analyzed. The brief table below abstracts the total costs of the least expensive alternatives for the four public systems of higher education. (It was not feasible to include the private colleges in a similar analysis; however, the computer capacity implied here for the public systems is conveniently distributed for access by private colleges.) The costs quoted include equivalent monthly lease of equipment plus monthly operating support.

University of Minnesota System (U-2)	$321,000/month
State College System with Two Central Computers (S-2)	172,000
State Junior College System: Central Administrative Computer plus Time-Shared Instructional Computer (JA-1 plus JI-1)	69,000
Area Vocational-Technical Schools using Regional Centers (instruction only) (V-2)	65,000
TOTAL	$627,000/month
Fully Regionalized Computer Systems (R-1), plus Central Administrative Computer for Junior Colleges	$636,000/month

One of the interesting conclusions from this analysis is that regionalization of computer facilities within higher education does not result, at present, in significant cost savings. The savings in communication line costs are small because of the way institutions are distributed geographically. With a few notable exceptions, these savings are partly offset by increased costs of services from regional computers, which provide many kinds of services rather than specializing in one application for which the system can be optimized (e.g., instructional time-shared computing).

RECOMMENDATIONS AND DEVELOPMENT SCHEDULES

This final section presents:

- a series of recommendations for actions or policies — in general, for each of the five systems of higher education, and for the Higher Education Coordinating Commission;
- a rather specific five-year schedule for developing computing capability in Minnesota higher education, complete with order-of-magnitude cost estimates;
- a more general indication of developments during the second five-year period, 1975-1980;
- some comparative information on other cost figures in higher education to place the cost estimates in perspective; and
- suggestions for priorities and planning to use the funds which may become available.

In a certain sense, the section could be considered a "Master Plan" for computers in Minnesota higher education. The recommendations and funding estimates, however, must be thought of as guidelines; they must not be used as rigid, specific plans. The scope and time available to complete the study have not been sufficient to develop specific, detailed implementation plans, which in any case are the responsibility of the institutions and systems themselves.

As presented briefly in this summary, the recommendations are organized somewhat differently than in the complete report, to emphasize their statewide implications rather than their relation to the institutions with which they may be most directly associated.

Goals and General Recommendations

- Minnesota higher education should attempt to achieve by 1975 a computer capacity for education and administration equivalent to that enjoyed by the best-equipped colleges and universities in 1967. That is, the *Pierce Report* goals should be achieved throughout Minnesota higher education by 1975, and an administrative computer capacity should be established capable of supporting college management information systems and program planning and budgeting.

- It is neither necessary nor desirable to establish full-scale educational programs in Computer Science or Data Processing at all public institutions of higher education.

- Computer installations in higher education must be operated on a service-oriented basis, with instruction and training applications normally scheduled during hours convenient to students. A service orientation, including a meaningful voice for all major users in setting priorities and policy, is *indispensible* for the successful functioning of regional or statewide computer services.

- The capacity for research computing should be available to those institutions with missions including research. Such computing is supported appropriately in the same way as other research activities, and should not require special funding.

- Institutions which train teachers and educational administrators, and the State Department of Education which certifies school personnel, should be requested to establish degree and certification requirements which include appropriate training in computer and information technology and data processing. Future school administrators and teachers in certain fields (e.g., science, mathematics, business education) cannot be considered as adequately prepared for their job without some competence in managing and using information systems and computers.

Recommendations for Regional and Statewide Facilities and Programs

- Existing regional computer centers within higher education should be supported at a level which will permit them to provide adequate regional services. In particular, funds should be provided to expand the communications capability of the University's CDC 6600 computer so that it can service more outside users from remote terminals; and adequate operating support should be provided to the new Regional Computer Center at Mankato State College, so that this experiment in providing computer service to a wide variety of institutions within and outside of higher education has a realistic chance to succeed.

- A Regional Computer Center at St. Cloud State College should begin with a medium-sized satellite computer to the Mankato Regional Center, for installation in 1973. If the Regional Center concept is successful, this satellite would be expanded in 1975 to a full Regional Center. However, this and other expansion in the size or numbers of Regional Computer Centers should proceed only after a careful evaluation of the experience from existing Centers.

- To meet the instructional computing needs of the State Junior Colleges and many private colleges, and the needs of the University of Minnesota for time-shared and other interactive computing, a statewide time-shared computing facility should be established. Initially, this facility would be under the management of one of the systems of higher education — probably the University of Minnesota — but with operating policies established by all users. As the system grows and multiple computers are added, it may be desirable to decentralize the locations and managing institutions, still retaining some statewide

coordination of policies and systems development (hardware and software).

- Planning should commence immediately for a Statewide Automated Library System, based on preliminary work done by the University of Minnesota Library Systems Staff, other libraries, and library groups in the State, and evaluation by Becker and Hayes, Inc. (Appendix H.2). The mechanism to begin this effort should be a Planning Board established by the Higher Education Coordinating Commission, with the mission of developing for the 1971-73 biennium either a complete plan, or interim measures to continue present activities which will contribute eventually to a Statewide Automated Library System.

- To support investigation of the potential effectiveness and economies of Computer-Assisted and Computer-Managed Instruction, a statewide facility should be established to provide computer services and other technical support to development activities at the University's Center for Research in Human Learning *and* at similar centers throughout the State of Minnesota. This statewide support facility would also coordinate development programs in Computer-Assisted Instruction, and aid in their transition from development to operational status.

- Research and development activities associated with information services depending on accurate, continuously-updated, computerized data bases should be supported. It is recommended that the Department of Administration, the University of Minnesota, and other state agencies jointly develop the projects, funding requests, and contracts necessary to implement such development programs which are of potential value to the people of Minnesota.

Recommendations Related to Individual Systems

University of Minnesota

- Special laboratory computers are required for certain professional programs at the University, especially in computer science and engineering. If these programs are to maintain their quality, such laboratory computers must be funded.

- The Coordinate Campuses of the University can most effectively be supplied with computer capacity as follows.

  Duluth – a medium-sized computer, somewhat expanded from the present configuration. If the Regional Computer Center concept prevails, then Duluth would expand into a Regional Center for northeastern Minnesota during the last half of this decade.

  Morris – remote terminals to the University's CDC 6600 and to the statewide time-shared computer facility.

  Crookston and Waseca – terminals to the statewide time-shared computer facility.

State College System

- As soon as possible, each of the state colleges (except Mankato) should be provided with a remote terminal capable of interfacing with both the Mankato Regional Computer Center and the University's CDC 6600. This will enable the colleges to begin providing needed service to their students and administration, and to acquire experience in the remote use of large computers.

State Junior College System

- In addition to instructional computing via the statewide time-shared computer facility, the Junior Colleges require a somewhat larger administrative data processing capacity than they now possess. It is recommended that they acquire a small third-generation computer with adequate magnetic disk storage and an efficient COBOL compiler. Although mail and parcel service has been and will continue to be adequate for most of their data communications, the Junior College Data Processing Staff should, within a few years, begin to develop a remote query system for more rapid access by the individual colleges to certain kinds of information.

Area Vocational-Technical Schools

- Over the next five years, Area Vocational-Technical Schools with programs in Data Processing and Accounting should gather experience in using remote terminals to large computers, and in using business minicomputers which can operate either by themselves for small processing jobs, or as remote terminals to a large computer. It is particularly important for one or two of these terminals to begin extensive use of the Mankato Regional Center as soon as possible, so that experience in working with a center of this kind can be acquired. After a few years of experience with this variety of terminals and computers, it will be possible to make an informed decision on the most effective and economical future direction of computing facilities for vocational training.

Private Colleges

- Technical assistance and advice should be provided by the staffs of the large state-supported computer installations to help the private colleges develop communications interfaces between their terminal and computer facilities and those of the public institutions. In addition, computer systems in the public institutions — most especially the regional and statewide facilities — should provide services to private colleges at cost.
- Within constitutional constraints, the State should aid the development of computing capacity in the private colleges by supporting regional and statewide computer facilities and data communications networks, and by providing grants to the private colleges to subsidize their use of available computer services. It is recommended that these subsidy grants build up to cover approximately half the cost of the computer services (exclusive of terminal and communications costs) required to meet the educational needs of the private colleges.

Recommendations Addressed to the Higher Education Coordinating Commission

- To increase the efficiency and effectiveness with which its needs for information processing can be met, the Higher Education Coordinating Commission should establish a full-time staff position for an analyst to analyze and advise on program and budget requirements for information and data processing, and to act as a consultant and service manager for applications programming. In addition, remote access to computing facilities and data bases should be made available to Commission staff through the State College Board terminal in the Capitol Square Building.
- It is recommended that the Higher Education Coordinating Commission establish a mechanism to develop standards for the coordination, compatibility, and security of system data bases and applications programs.
- The Higher Education Coordinating Commission should establish a technical committee to develop the specifications, implementation standards, and coordination mechanisms to create and maintain compatible communications interfaces between all terminal and computer facilities in higher education. This effort should be coordinated through the Telecommunications Section of the State Department of Administration with similar standards for other agencies of state and local government.
- The Minnesota Higher Education Coordinating Commission should explore with its counterpart in North Dakota the possibility of sharing computer resources. A reasonable first step in this direction would be to invite a North Dakota representative to participate in the work of the previously-mentioned Technical Committee on Communications Standards.
- An *ad hoc* committee should be established to open channels of communication and

coordination among systems and institutions offering in-service and pre-service training in computing and data processing, and to promote an increase in the amount and geographical distribution of such training.

- The special appropriation of $300,000 by the 1969 Legislature has been most effective in stimulating the development of many useful computer applications and services in Minnesota higher education. It is recommended that such appropriations be continued at a similar or slightly expanded level, that they be made to and disbursed by the Higher Education Coordinating Commission, and that the Commission prepare a report to each session of the Legislature summarizing and evaluating what has been accomplished with the development funds.

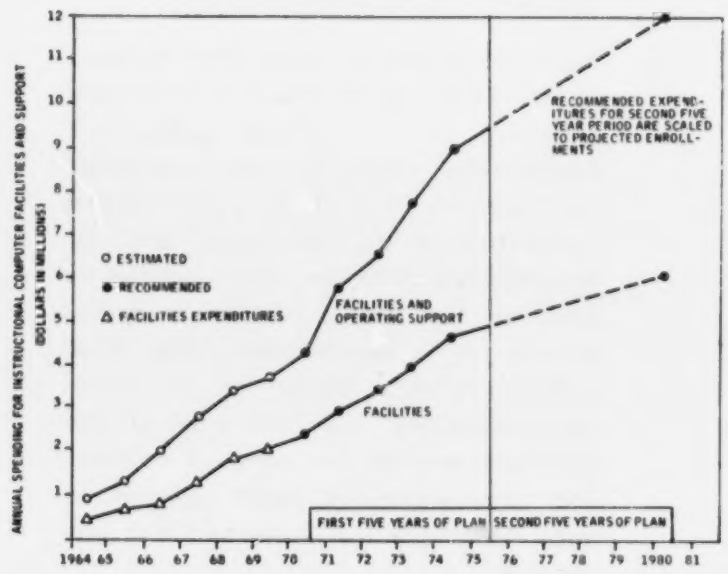
The interrelationships between institutions and systems implied by the preceding recommendations will require a large degree of coordination in developing the facilities and organizations required to achieve an effective and economical computing and information processing capacity in Minnesota higher education. In approving this report, the Higher Education Coordinating Commission has adopted a specific procedural policy to insure the coordination of plans and budgets for computing facilities and services in the various systems and institutions of higher education. A statement of this policy appears following the Recommendations in the complete report.

Development Schedules

Converting the recommendations above into specific facilities and costs for the five years 1970-75 yields the contents of Tables 5.1 through 5.5 in the complete report. The total annual costs estimated for facilities and operating support over this period are summarized in the table below, where the 1970-71 expenditures are those actually planned and committed for that year, and the facilities costs are in terms of equivalent annual lease, regardless of whether the facilities are actually being leased or have been purchased.

Fiscal or Academic Year	Facilities	Operating Support	Total
1970-71	$2,360,000	$1,864,000	$4,224,000
1971-72	2,949,000	2,864,000	5,813,000
1972-73	3,463,000	3,164,000	6,627,000
1973-74	3,997,000	3,754,000	7,751,000
1974-75	4,672,000	4,338,000	9,010,000

The specific facilities recommended for this five-year period are illustrated schematically in Figure 5.1 of the complete report, along with a general indication of the expansion which will be required to maintain an adequate computing capacity during the next five-year period 1975-80. The small graph below is a reduced version of Figure 5.2, presenting the costs summarized in the above table, bracketed on the left by the estimated expenditures for computing in Minnesota public higher education from 1964 to 1970, and on the right by the estimated costs for 1975 to 1980 scaled according to the projected enrollment increase from 1975.



Although the total expenditures recommended are certainly formidable, they appear more reasonable on a per-student basis. If the goals of adequate computing are achieved in 1975, then the cost per student per year, according to the estimates here, would be about $56, compared with $60 estimated by the *Pierce Report* in 1967. The *Pierce Report* also points out that the cost of library services in colleges and universities was between $50 and $200 per student per year in 1966, and the cost of chemistry laboratory instruction was about $95 per chemistry student per year. The $8.8 million for computing recommended for 1974-75 is about 2.5% of the total operating costs estimated for public higher education in Minnesota for that year, compared with 4% of operating costs recommended nationally for computing in higher education by the *Pierce Report.*

Despite these indications that the expenditures recommended here are reasonable, it is clear that, when balanced against other demands on the tax dollar, it may not be possible to achieve the desired computing capacity in higher education as early as 1975. If support cannot be provided at the level recommended, then it is the opinion of the authors of this report that priorities for spending available funds should include support for the existing facilities; establishment of a limited-capacity statewide time-shared computer facility to serve existing needs in the Junior Colleges, the private colleges, and the University; and establishment of a center to support development work on Computer-Assisted and Computer-Managed Instruction throughout the state. However, it is properly and ultimately the responsibility of the individual institutions and systems to higher education to plan the facilities and programs in detail and to set the priorities jointly. The policy for planning and budget coordination adopted by the Minnesota Higher Education Coordinating Commission as a result of this study establishes a sound mechanism to accomplish these tasks.

LOCAL GOVERNMENT

In large measure, local government is where the "action" is. It is here that many of the domestic issues are centered, and it is here that much of the governmental service to the public is rendered. It is also at the local government level that the science and art of systems analysis and computerization can be of most assistance to public administrators in effecting both better service and economies.

Local governments have generally lagged behind the Federal and State governments in such efforts. But there is a growing interest and concern among local governments; the question is how best to approach the overall problem. With few exceptions, "go it alone", uncoordinated efforts by local governments will not get the job done. The extent of the job in Minnesota is 87 counties, 139 municipalities of 2,500 population or greater, and 440 elementary-secondary school districts.

In Minnesota, the problem has been recognized by the Legislature, the Governor, the Governor's Committee on State Information Systems, the State Commissioners of Administration and Education, and others. The Legislature considered legislation relating to local government computerization at the 1969 session and has continued its interest since the session. The Governor in Executive Orders No. 15 and 56 has assigned responsibility to the Computer Services Division in developing local government information systems including staff support for systems design and programming and pilot project computerization. The Commissioner of Administration, in a recent reorganization of the Computer Services Division, established a Local Government Unit in the Planning and Coordination Section of that division. The Governor's Committee on State Information Systems was involved in these actions by the Governor and the Commissioner of Administration, and its chairman believes the local government area offers the greatest potential payoff from information systems implementation. The Commissioner of Education and the State Board have made clear their interest in efficient development and use of computers.

Local government interest has been gradually growing. A State-Local Data Systems Group has been set up to begin work on coordinated efforts in information systems development.

The business of local government is particularly susceptible to assistance from information systems and computerization. The evidence of service such as a birth certificate, building permit, or welfare payment may be produced by a computer. The computer can serve as the repository of the raw material to produce such products; and based on the same data, the computer can provide management information to control program execution and evaluate program performance.

With some exceptions, however, local governments have not been in a position to take advantage of the new technology and are struggling with masses of data in manual files which cannot be focused on current problems in a timely fashion. Further, most efforts to improve the situation have emphasized *how* to do something better rather than looking to the objectives and determing *what* is to be accomplished.

What is needed? Information systems are required to serve operational needs and at the same time generate the data necessary for research and planning and permit interrelationship among systems for both operational and planning purposes. In local government, four data bases, or files, are needed: natural persons, legal persons, real property, and personal property. The data

elements in the individual agency files should serve the day-to-day operating needs and planning and research requirements and should be relatable through a master index file, under extremely carefully prescribed controls, to data in other files. To the extent possible, routine decision making should be assigned to the system.

Development and implementation of such systems are sizable tasks and require extensive coordination to assure that intergovernmental information needs are met and to avoid the cost of redundancy. In April 1968, the Intergovernmental Task Force on Information Systems emphasized the need for such coordination in its imaginative and authoritative report entitled "The Dynamics of Information Flow." The Task Force, composed of persons representing Federal, state, and local governments, addressed the needs for intergovernmental data systems and exchange and the means for meeting those needs.

Although there is a substantial amount of information on the use of computers in local government, most of it relates to specific applications in individual government jurisdictions. In fact, a measure of the redundancy, present and potential, of systems design and development cost might be obtained from a review of the literature. There is some evidence in the present trend, however, to make one optimistic about significant improvements in local government information systems and computerization.

Among the hopeful signs is the USAC (Urban Systems Advisory Committee) project administered by the Department of Housing and Urban Development. This project has as its objective the building of municipal information systems that will be of value to jurisdictions other than those in which they are being developed. St. Paul, Minnesota, is one of six participating cities and is developing a human resources information system. Another example is the State-financed MINCIS (Minnesota Crime Information System) and its federally aided adjunct project SEARCH which serve local law enforcement agencies throughout Minnesota.

Several states are responding to the local government information systems problem in ways similar to those recommended herein for Minnesota. For example, both California and Pennsylvania have set up intergovernmental boards to establish guidelines for intergovernmental information systems and computer development. There are also a number of examples of local government cooperative development of computer facilities or data interchanges.

STATUS IN MINNESOTA

Questionnaires were used in an attempt to obtain a picture of county and municipal status in Minnesota. With few exceptions, county and municipal governments are in beginning stages of mechanization or have done nothing. Little cooperative development has occurred. County and municipal governments in Minnesota are generally at the threshold and at a point where coordination and cooperation can be most easily realized.

The situation in school districts differs in some degree from that in counties and municipalities. This appears to be the result of three factors: State Board and Department of Education support of efforts to tackle the problem; the TIES (Total Information for Education System) development; and the interest and action in many school districts on instructional uses of computers. State department financed reports have addressed the problem of coordinating computer facilities for school districts, concluding that centers based on state regions would be appropriate. In July 1970, the State Board of Education adopted a policy statement endorsing the regional concept and a close tie to higher education.

TIES was established in 1967 under the Minnesota Joint Powers Act to provide information systems development services and computer facilities for a group of school districts.

Now totaling 29 school districts with an enrollment of nearly 240,000 students, TIES is providing both administrative and instructional computer facilities. A recent TIES evaluation report summarizes TIES' problems and accomplishments, both of which have been substantial, and concludes that TIES is in the process of "restoring the confidence of its users" and that by "strict adherence to system development discipline, TIES can continue this upward trend and move to new levels of service." It appears that both in scope of service and size, TIES stands at or near the head of the class nationwide in coordinated local government computer efforts.

Local governments striking out on their own in the information systems – computerization maze are destined, with few exceptions, to follow a course that at best leads to marginal results and at worst to disaster. The process begins with a partial feasibility study on mechanizing a few applications which often results in obtaining a small computer, often not suitable for the few applications and totally unsuitable for the information systems task that needs doing. It continues with a staffing search and the first round of implementation which is undertaken in an unrealistic time frame, resulting in badly missed schedules, heavily overrun budgets, and disenchanted users. Ultimately there is something to see, but it has no resemblance to an information system. At this point it becomes clear that the facility is not adequate for the job, leading at some later date to an upgrading to a larger computer resulting in costly re-programming. The data base needed for the information system, however, is still non-existent. Cost/benefit evaluation then proves catastrophic.

In order for effective coordination to exist, however, there must be agreement on certain fundamental principles among the users; or success is imperiled. These include: an information system must be implemented for each service program; highly qualified systems analysts and medium-to-large scale central computer are required; smaller governmental jurisdictions can benefit proportionately to the large; the computer's availability and capacity are important, not its ownership or location; the computer facility is in the nature of a utility; user management must get deeply involved with the necessary comprehensive systems design; common systems development to cover the needs of similar governmental jurisdictions is feasible; programming is a professional matter not requiring the attention of individual jurisdictions; computer management is best left to professionals; priority should be given to systems with largest payoffs; conversion planning is essential; intergovernmental information requirements demand consideration and priority.

Direct and indirect cost/benefits of local government information systems and computerization in Minnesota are not clear and would be in retrospect virtually impossible to determine. It can be said with certainty, however, that a coordinated approach will cost far less than a series of "go-it-alone" approaches. It can be said with virtual certainty that cost trends (costs generally higher but computer hardware costs lower) will make computerization increasingly more attractive economically in the future. It can be said with high probability that the payoff from information systems-based decisions will far exceed other cost/benefits.

A series of recommendations are made to provide a framework within which Minnesota local government can move in an orderly, cost effective way, without delay, toward the development and implementation of information systems and other computerization needs. The organizational recommendations are believed to be most important recommendations in this report.

LOCAL GOVERNMENT RECOMMENDATIONS

Information systems and computerization place substantial demands on legislative and executive groups in local government. The decision to move into these areas is a major one which, taken seriously, requires such officials to define objectives and clearly delineate programs and policies in all functions of government.

Recommendations and guidelines to serve as a plan for accelerating the efficient development of Minnesota local government information systems and computerization are under these headings:

- General recommendation for State policy.
- Organizational requirements.
- Approaches to coperative centers.
- Area Computer Centers.
- Orientation and training.
- Funding.
- Implementation suggestions.

General Recommendation

In summary, it is the strongest recommendation in this report that in 1971 the Legislature establish an Intergovernmental Commission on Information Systems with coordinative authority over all cooperative efforts in local government information systems and computerization. The authorities and responsibilities of the Commission are limited to those necessary to attaining a coordinated, statewide approach to the building of local government information systems and to establish the framework for the orderly and efficient development of cooperative computer facilities. Implementation of this recommendation would call for amending the Minnesota Joint Powers statute (a) to require as a final step, insofar as information systems and computerization are concerned, approval by the Intergovernmental Commission and (b) for any such joint efforts involving school districts the approval of the State Board of Education prior to Commission action. In addition, *developmental funding* by the State on a matching basis with local government is recommended as is Commission control over Federal, State, or foundation funding for all local government information systems and computerization *developmental efforts.* It should be noted that the recommendations are limited to cooperative and coordinated activities; "go-it-alone" efforts by local government are not recommended to be in the purview of the Commission.

Organizational Requirements

A formalized organization structure must be established in order to provide the framework and the machinery for orderly development of local government information systems and computerization.

- An Intergovernmental Commission on Information Systems should be established with coordinative authority over cooperative efforts in information systems and computerization in local government. Only in this way will it be possible to look at the entire problem in a manner that can maximize the cost effectiveness of such efforts. State Board of Education approval should be required for any joint effort of this nature on the part of school districts, prior to submission of the plan to the Intergovernmental Commission. It is believed that through these two steps the statutory responsibilities of the State Board may be met and the necessary coordination be obtained through the Commission. The authorities and responsibilities recommended for the Commission must include *only* those necessary to permit statewide coordinated efforts toward compatible information systems and to assure carefully planned development of computer facilities throughout the state. In addition, the recommended representation on the Commission is designed so as to assure an effective voice for all groups. The recommended responsibilities and authorities of the Commission are:

1. To establish goals and objectives for intergovernmental information systems in Minnesota as well as general policies governing coordination, cooperation, joint efforts, and priorities.
2. To authorize establishment of Area Computer Centers; to promulgate policies and procedures assuring the coordination of the efforts of Area Computer Center Boards, so that an integrated statewide system may

ultimately be developed; to establish (a) criteria for determining economic feasibility for the Centers and the several information systems, and (b) procedures for measuring actual versus expected cost/benefits.

3. To coordinate the development and implementation of standards of compatibility of procedures, programming languages, codes, and media to facilitate the exchange of information within and among systems.

4. To review and approve or disapprove all applications requesting Federal, State, or foundation funding for planning and development of programs with potential impact on local or intergovernmental information systems.

5. To review and comment upon policies affecting intergovernmental information exchange established by the Governor's Committee on State Information Systems and/or the Director of Information Systems and provide advice to the State on long-range policies, programs, and plans relative to intergovernmental information systems.

6. To develop policies and design procedures for the security of data in local government information systems and for safeguarding the confidentiality of such data consistent with state statutes, local ordinances, and pertinent administrative rules and regulations (also see recommendation in Part III on security and privacy).

- It is recommended that the Minnesota Joint Powers statute be revised to require approval of the Intergovernmental Commission on Information Systems prior to establishing any future cooperative effort in information systems and computerization. The reason for this recommendation is that the coordinated and efficient development of a statewide information system has to be accomplished within some general framework. Only the Intergovernmental Commission will have this viewpoint. If this is not done, it will be virtually impossible (a) to avoid the overwhelming cost of redundancy and (b) to develop standardized and compatible information systems.

- In order to attain a true intergovernmental base, members of the Commission should represent all governmental echelons involved with intergovernmental information requirements. Majority representation, however, should be given to local governments as a group. Accordingly, it is recommended that the Commission membership should consist of two persons representing counties, two representing municipalities, three representing school districts, three representing the State Government, and one each from the Governor's Committee on State Information Systems and Minnesota regional government. The State members should be the Director of Information Systems, a representative of the State Board of Education, and a representative of higher education. A Federal government observer should be obtained from a department such as HEW or HUD. It is further recommended that the appointments be made by the Governor, to serve at his pleasure, and that local government representation be made from nominations submitted by the Association of Minnesota Counties, by the League of Minnesota Municipalities, and jointly by the Minnesota School Board Association and the Minnesota Association of School Administrators. Finally, it is recommended that the State Director of Information Systems be chairman.

- It is recommended that the Local Government Section of the Division of Information Systems serve as staff for the Intergovernmental Commission. The advantages of this over establishing a new group are that (a) the necessary interfaces with state agencies will be more readily attainable, (b) staff costs will be minimized, (c) staff specialists from the Division of Information Systems will be more readily available and more effectively

used, and (d) the relationship between the recommended chairman (Director of Information Systems) and the staff should be most effective. The disadvantage is the possibility that the State's interests may be given undue weight, a possibility that the Commission itself should be able to control.

- It is recommended that Area Computer Center be authorized by the Commission and operated by the Area Computer Center Board under broad policies established by the Commission to assure integrated, consistent, and economical systems analysis, programming, and computerization efforts. The Area Computer Center Board, limited to a workable number such as seven, should be elected by the local governmental bodies involved with the Center.

- In those cases where departments of the State government have supervisory or regulatory authority over local governmental functions, it is recommended that requests for Federal, State, or foundation funding for development of intergovernmental information systems or computerization require approval by the State department involved prior to submission to the Intergovernmental Commission for final approval.

Approaches to Cooperative Centers

The only cost effective computer cooperation for most local governments in Minnesota is the common use of systems and computers. The alternative methods are essentially of three types: geographically oriented, such as a county, a group of counties, or a State region; functionally based serving school districts, for example; or a combination such as a State region wherein one Area Computer Center serves all school districts and another serves all counties and municipalities.

Although the recommendation of specific locations is beyond the scope of this study, it is recommended that the presently designated State regions be used as a basis for preliminary planning of Centers. A Center should cover one or more complete regions or a part of a heavily populated region, but not parts of two or more regions.

Major factors to be considered in establishing a Center are: (a) a service base sufficient to justify the center: total population and school enrollment are principal examples; (b) general readiness of the potential clientele to make use of the facilities; (c) adequate financing; (d) contractual agreement as to charges, services, and coordination personnel; (e) geographic area and distances; and (f) communications cost/benefit. These criteria are dynamic because of external forces and because of their mutual interaction.

Area Computer Centers

Against the background of the preceding discussion, specifics of Area Computer Centers are now considered. There are three alternatives that appear to be feasible in Minnesota.

- **A Center created anew under authority of the Intergovernmental Commission.** An example of this type of Center is TIES, in which case twenty school districts set up a new computer center under the Joint Powers Statute, and employed the systems, programming, and operating staff to carry out all phases of development and operations.

- **A Center already existing in higher education.** Certain of the larger higher education institutions have or will have computer configurations with the capacity to handle information systems and computerization requirements of local governments including school districts. Provision of such service would be consistent with the institution's public service objectives. The development of instructional uses by such an institution could be most helpful to school districts. Depending upon developments in type and quantity of utilization over the next few years and the composition of the higher education network as discussed in Part IV of this report, the institution may find that it would be faced with a choice of serving only higher education, limiting its service

to higher education in favor of serving local government, or greatly increasing its computer capacity.

- **A Center already existing in an AVTS.** No AVTS now has a computer configuration capable of handling the kinds of information systems and computerization called for in this report. In fact, most of the present computer configurations in the AVTS's are less than adequate for the educational needs of those schools because of their size and generation. The larger configuration necessary for an Area Computer Center could fill the educational need. Further, the programming and operational requirements of a Center would offer substantial opportunity for excellent student training. The AVTS's, under school district control, are a logical choice to provide service to school districts and their schools. In addition, the AVTS's in many communities enjoy a close relationship with county and municipal governments.

Orientation and Training

Information systems, involved as they are with the broad, complex, and largely innovative concepts of systems analysis and computerization, simply cannot be developed without a significant training effort. Curricula should be established for elected officials, for top and middle management, for supervisory personnel directly involved in services likely to be computerized, and for local government personnel who will form or be the coordinative link with, the information systems cadre.

Educational programs of value to local government information systems efforts should be catalogued and periodically disseminated to local government through the existing channels of the Association of Minnesota Counties, the League of Minnesota Municipalities, and the Minnesota Association of School Administrators.

Of equal or perhaps greater importance is the need for such emphasis in teacher training sequences. Recommendation No. 7 in Part IV of this report states, "The major problem in implementing modern information systems and computer instruction technology in local school districts is a lack of people trained in these fields."

Funding

It appears unrealistic to expect developmental funding by local government alone. Some contribution, however, should be expected from local government, perhaps on a matching basis. Because the need is so great and the time so short, it is recommended that the State make available a substantial sum for developmental work. This money would be available for expenditure by the Director of Information Systems upon recommendation of the Intergovernmental Commission on Information Systems. The funds would be available for developmental purposes. In the main, they should be used to develop or obtain systems and to fund pilot projects, but they should not be available to subsidize an on-going service to a local government.

The amount recommended from the State budget for the next biennium is $1,000,000 for use in development of county and municipal information systems, $700,000 for school districts, and $200,000 as the initial budget for the Local Government Section. The county-municipality sum should be available for use through one or more Area Computer Centers on a matching basis (for example, $3 of state funds for $1 of local funds). The distribution between county and municipal systems should be determined by the Intergovernmental Commission with a principal criterion being early pay-off.

The school district distribution is suggested as a $1 augmentation of school aid per year (or $2 the first year) for all of the students in TIES, approximately 240,000, and all of the students in the second TIES-like Area Computer Center, assuming the new center covers approximately 100,000 students. The money would be made available by the Director of Information Systems to TIES and the new school district Area

Computer Center upon recommendation by the Intergovernmental Commission after reviewing plans for development to be financed by the funds. The TIES suggestion assumes that all TIES systems and programs will be available without charge to other Minnesota jurisdictions.

The amount of money recommended could easily be doubled and spent productively. The odds are high that every dollar invested in this way will return an extremely rewarding pay-off to the taxpayers in Minnesota. It would be appropriate, of course, to seek Federal and foundation funding assistance for both of these efforts. Pooling of resources and efforts among the larger units of local government and the state in specific subject matter areas should also be attempted. In particular the possibility of Federal funding should be aggressively pursued by the Commission, either as a Minnesota project or in combination with other states. Further, joint development action with other states should be explored.

IMPLEMENTATION SUGGESTIONS

Specific action to implement the general recommendations above is outlined below. These actions assume legislative adoption and enactment of the general recommendations made previously. An interim approach is also suggested so that development can proceed prior to such action.

1. The Intergovernmental Commission on Information Systems should authorize an Area Computer Center dedicated to the development and implementation of information systems for county and municipal governments. It is recognized that accomplishing this task may be difficult. However, the local government needs, the availability of some State and/or Federal funding, and significant State technical assistance should provide incentive to a group of progressive jurisdictions.

2. The Intergovernmental Commission should spell out its delegation of authority and assignment of responsibility to the Area Computer Center Board and then conduct an election for the Board.

3. The Area Computer Center Board should appoint a Standards Committee and a Systems Development Committee. The Standards Committee, assisted by the Local Government Section, Division of Information Systems, should undertake the sizable task of drafting a standards manual for local government in Minnesota, including among other things, a data dictionary. Every opportunity should be made available for other local government input. Draft manuals should be circulated to all counties, all municipalities (over 2,500 population), TIES, the Metropolitan Council, and the State Department of Education for review and comment. The initial standards manual should ultimately be presented to the Intergovernmental Commission for approval and would then serve as the local government standards manual.

   The objective of the Systems Development Committee is to obtain or develop sound information systems. The systems selected for initial development should be those with greatest payoff. Further, they should be capable of modular development so that payoff may be realized from part of the system. As with standards, the systems design must be submitted to all jurisdictions for review. Local governments with particular interest, expertise, or accomplishment in related systems should be invited to participate in development of transferable information systems. The Local Government Section should devote much of its effort to the work of this Committee.

4. In the initial stages, the Area Computer Center should make use of a computer capability other than its own. It is expected that only a sizable computer configuration can handle the information systems that will be developed. The Center simply could not utilize such equipment effectively at the outset.

5. The implementation of all except the most proven of existing systems should be limited to one user. Until extensive testing is completed, *no additional users* should be allowed to use a new application. Comprehensive user's manuals *must* be in being prior to implementation.

6. The Area Computer Center Board should develop written policies, regulations, and procedures governing the operation of the Center including a model contract for services; input and output control requirements; security, privacy, and confidentiality of data; charging for services rendered; etc. These should be reviewed and approved by the Intergovernmental Commission inasmuch as they should serve as a pattern for other centers.

7. The Area Computer Center Board, in consultation with the Intergovernmental Commission, should establish an operating plan for the first two years and a corresponding budget.

8. Selection of a director for the center and an appropriate site should be made by the Area Computer Center Board.

9. The Intergovernmental Commission should authorize a second Area Computer Center composed of school districts, preferably be based on a region (MESA and conduct an election of the Board. The Center *should not* begin from scratch but should utilize systems now operational such as TIES or the Honeywell Newport-Mesa, EDINET combination.

Prior to legislative action, the State-Local Data Systems Group and the Local Government Unit of the Computer Services Division should lay as much groundwork as possible for the initiation of the foregoing program.